Mapping Data Flow Models to the Palladio Component Model

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Motivation

Software Architects

Sketched Architecture

Will quality goals be achieved?

Architecture Models

Are all models consistent?

Analyses

other models

validate

valid order

extract items

other tools

Motivation → State of the Art → Foundations → Running Example → Mappings → Process → Summary
High Level Challenges and Goals

Challenges of multiple models and analyses
- Consistency between separated models not trivial
- Additional maintenance effort for multiple models
- Analysis results have to be about same version

Benefit of using dedicated models and analyses
- Modeling approach tailored to quality analysis
- Established analyses provide good predictions
Topics in this Talk

Covered Models

• Data Flow Diagrams (DFDs) [DeMarco79]
• Palladio Component Model (PCM) [Reussner16]

Covered Challenges

• Consistency: Mapping rules between DFDs and PCM
• Maintenance Effort: Idea for automated PCM stub generation
State of the Art

Relation Data Flow and Control Flow Diagrams

- Mapping DFD to object-oriented design [Alabiso88]
  handling of ambiguities and design space not clear

- Mapping DFD to fine-grained behavior [LarsenPlatToetenel94]
  no realistic DFDs (1:1 mapping of inputs to outputs)

Resolving ambiguities

- Control flow nodes in DFDs [WardMellor86]
  breaks separation between requirements and design

- Relation inputs and outputs [TsePong89][BrunzaWeide93]
  Does not match required level of abstraction
Foundations

Data Flow Diagrams

- Defined by DeMarco
- Sources, sinks, processors, files, data flows

Data Mapping Extension

- Mapping of input data to output data [BrunzaWeide93]
- $E$: Set of all entities
- $D$: Set of all data
- $(e, D_{in}, D_{out})$: Mapping with $e \in E \land D_{in}, D_{out} \in D$
Running Example

Customer

order

pay
Running Example

(Customer, ∅, {order})
Running Example

(Customer, ∅, {order})
(order, {order}, {orderConfirmation, bill})
Running Example

(Customer, ∅, {order})
(order, {order}, {orderConfirmation, bill})

(Customer, {orderConfirmation}, {creditCardData})
Running Example

(Customer, ∅, {order})
(order, {order}, {orderConfirmation, bill})
(Customer, {orderConfirmation}, {creditCardData})
(pay, {creditCardData, bill}, {paidBill, payConfirmation})
Coverage of Views by Mapping Rules

Structural View
- Components
- System

covered

Behavioral View
- Usage
- Component Behavior

covered

Deployment
- Resources
- Allocation

not covered
Structural View – Components

Motivation  ➔  State of the Art  ➔  Foundations  ➔  Running Example  ➔  Mappings  ➔  Process  ➔  Summary

«DataType» Order
«DataType» CCD
«DataType» Bill
«DataType» OrderConfirmation
«DataType» PayConfirmation

«Interface» IOrder
order(Order) : OrderConfirmation

«Interface» IPay
pay(CCD) : PayConfirmation

Order

Pay

(\text{order, \{order\}}, \{\text{orderConfirmation, bill}\})

(pay, \{\text{creditCardData, bill}\}, \{\text{paidBill, payConfirmation}\})

IPullBill
getBill() : Bill

State of the Art
Mappings
Running Example
»

Motivation
Structural View – System

«System»
OrderSystem

«AssemblyContext»
Order

«AssemblyContext»
Pay
Behavioral View – Usage

«UsageScenario»
Customer

«ScenarioBehavior»
Customer

«ELSC»
call order

«Delay»
wait

«ELSC»
call pay

«Workload»

(Customer, Ø, {order})  (Customer, {orderConfirmation}, {creditCardData})
Behavioral View – Component Behavior

«RDSEFF»
Pay::pay

«InternalAction»
process payment

«ECA»
get bill

Motivation  ➤  State of the Art  ➤  Foundations  ➤  Running Example  ➤  Mappings  ➤  Process  ➤  Summary
Mapping Data Dependencies to Signatures

### Assumptions

- Identification of caller
- All data has to originate from and go to caller

```
«Interface»
IOrder

order(Order) : Bill, OrderConfirmation
```
Handling Different Data Sources and Targets

Pull

Customer

Order

getBill() : Bill

Pay

IOrder

order(Order) : OrderConfirmation

requirement: data must not be trigger for process

State of the Art

Foundations

Summary

Motivation

Running Example

Mappings

Process

Customer

order

orderConfirmation

bill

pay

(order, {order},
{orderConfirmation, bill})

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Software Design and Quality Group
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06 November 2019
Handling Different Data Sources and Targets

Push

Customer

satisfies data dependencies and triggers

Motivation  ➤  State of the Art  ➤  Foundations  ➤  Running Example  ➤  Mappings  ➤  Process  ➤  Summary
Envisioned Development Process

Requirements Engineer

DFD

Design Decisions

Automatic Transformation

Architecture

Tracing

Consistency Check

Software Architect

Report

Motivation ➔ State of the Art ➔ Foundations ➔ Running Example ➔ Mappings ➔ Process ➔ Summary
Conclusion

Summary

• Motivation: DFDs and PCM instances tailored for different quality analyses
• Approach: Mappings from DFDs to PCM are possible but not trivial
• Customization: Considering design decisions necessary for realistic architectures

Envisioned Benefit

• Use best fitting models and analyses for quality prediction
• Lower effort for using both models together

Future Work

• Identify further call patterns and complete mappings
• Define set of selectable design decisions
• Realize automated transformation to apply mappings
Literature References

- **[DeMarco79]**

- **[WardMellor86]**

- **[Alabiso88]**

- **[TsePong89]**
Literature References

- [BrunzaWeide93]

- [LarsenPlatToetenel94]

- [Reussner16]
Image References

Motivation

- Group of Architects
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